



Contribution ID: 211

Type: **Focus session invited talk**

Realising solitonic edge states of vortex lattices in planar Bose-Einstein condensates

Monday 1 December 2025 14:30 (30 minutes)

Edge states are excitations in many-body systems that are spatially localised at the boundary. They exhibit desirable properties such as dissipationless transport and robustness against disorder. These features make them central to phenomena like the quantum Hall effect and topological insulators.

In a rotating planar Bose-Einstein condensates (BECs), the ground state forms a triangular lattice of quantized vortices. While the linear normal modes of such vortex lattices have been well studied [1], recent theoretical work by Bogatskiy and Wiegmann [2] predicts the existence of nonlinear solitonic edge states which are the hydrodynamic analogue of the edge states of the fractional quantum Hall effect.

Here we search for solitonic edge excitations in finite systems within the nonlinear regime of the point vortex model, going beyond the coarse-grained hydrodynamic approximation. We compare our results to the predictions of Bogatskiy and Wiegmann and explore the feasibility of experimentally observing these edge states in ultracold atomic BECs [3].

- [1] L. J. Campbell, Transverse normal modes of finite vortex arrays, *Physical Review A* **24**, 514 (1981).
- [2] A. Bogatskiy and P. Wiegmann, Edge wave and boundary layer of vortex matter, *Physical Review Letters* **122**, 214505 (2019).
- [3] T. W. Neely et al., Melting of a vortex matter Wigner crystal, *arXiv:2402.09920* (2024).

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Session Classification: Focus Session: Ultra-cold atoms and quantum technology

Track Classification: Focus sessions: Ultracold Atoms and Quantum Technology